

## Two Species of the Genus *Actacarus* (Acari, Halacaridae) from Japan

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**ABSTRACT**—A new arenicolous halacarid mite, *Actacarus karoensis* sp. nov., is described and another species, *Actacarus illustrans* Newell, 1951, is newly recorded from Japan. *A. karoensis* is easily distinguishable from congeners on the basis of several characters including the shape of the genitoanal plate and length of the ovipositor. As for *A. illustrans*, it was noted that the Japanese specimens differ from the North American specimens in some morphological characters. These differences are regarded here as intraspecific variations.

### INTRODUCTION

Taxonomic knowledge of marine halacarid mites in Japan is limited. The first record of the family in Japan was in 1927, when *Halacarus spongiphilus* Kishida, 1927 was described from the abyssal zone in Sagami Bay [1]. An additional species, *Agauopsis okinavensis*, was described by Bartsch [2] from Okinawa, southern Japan. The present paper describes two species of the genus *Actacarus* newly found in Japan.

### MATERIALS AND METHODS

Specimens were fixed with modified Imamura's fluid [3], dissected in a drop of pure lactic acid, and mounted in gumchloral medium. Observation was made under a phase-contrast microscope using oil immersion, figures were drawn with the aid of a camera lucida, and measurements were made with an ocular micrometer. Sizes of idiosoma and gnathosoma were measured before dissection, while other parts were measured on dissected specimens.

**Terms:** The terms for body parts of halacarid mites follow Newell [4–7].

**Presentation of numerical data:** Metric charac-

ters are always given in micrometers ( $\mu\text{m}$ ). Meristic characters are sometimes given with ranges. Presentation of leg chaetotaxy and arrangement of subgenital setae follow Newell [7]. In describing positions of certain structures on a plate, the decimal system developed by Newell [6–9] is employed; for example, the statement 'setae at 0.44 on the genitoanal plate' means that the setae are located at a level 0.44 of the interval between the anteromedian point (0.00) and the posteromedian point (1.00) on the plate.

**Measured parts** (letters in parentheses refer to those given in Fig. 1): **Idiosoma:** Length (a), from the anteriormost margin of the anterior dorsal plate to the terminal end of the anal papilla; width (b), at the level of the lateral coxal margin of leg III. **Plate, genital foramen, and spermatophorotype:** Length (c), from the anterior margin to the posterior margin; width (d), at the widest level. **Gnathosoma:** Length (e), from the posterior margin of the base of the gnathosoma to the anterior tip of the rostrum; width (f), at the widest level of the gnathosoma. **Base of gnathosoma:** Length (g), from the level of the base of the palpal insertions to the posterior margin of the gnathosoma. **Rostrum:** Length (h), from the level of the base of the palpal insertions to the anterior tip of the rostrum; width (i), at the widest level. **Basal cheliceral segment:** Length (j), from the level of the most proximal end of the segment to the level of the tiny

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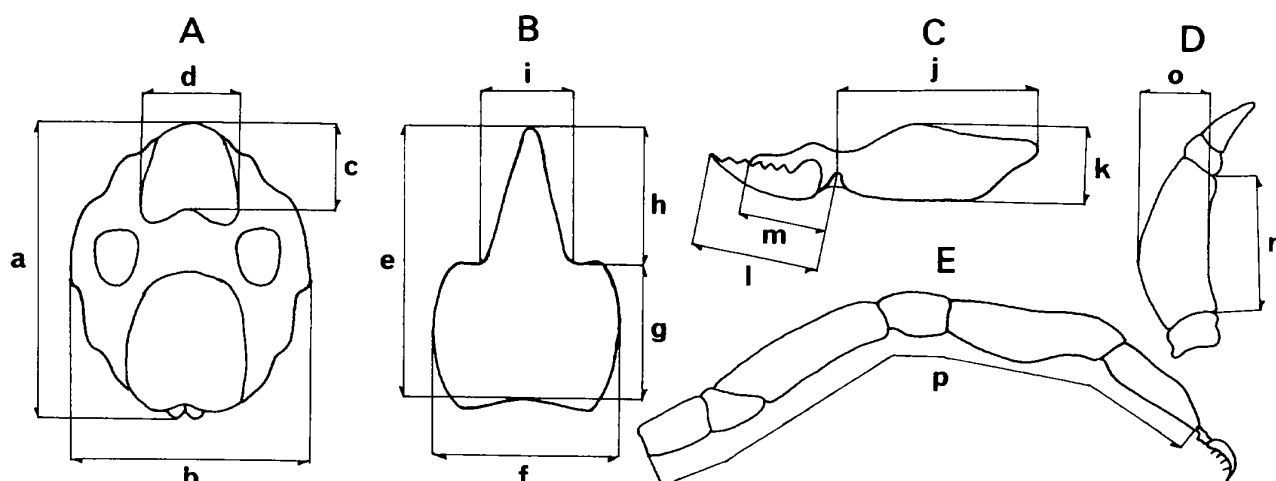


FIG. 1. Diagram of body parts measured. A, idiosoma; B, gnathosoma; C, chelicera; D, palp; E, leg. a-p: Measured parts explained in the text.

ventral gap; height (k), at the highest level. *Movable digit*: Length (l), from the level of the tiny gap to the distal end of the digit. *Fixed digit*: Length (m), from the level of the tiny gap to the distal end of the digit. *Palpal segment*: Length (n), from the proximal end to the distal end along the ventral margin; height (o), at the highest level. *Leg*: Length (p), from the proximal end of the trochanter to the distal end of the tarsal claw fossa along the ventral margin.

**Abbreviations:** AD, anterodorsal plate; PD, posterodorsal plate; OC, ocular plate; AE, anterior epimeral plate; PE, posterior epimeral plate; GA, genitoanal plate; ds, dorsal setae; aes-i, anterior epimeral setae; aes-ii-lat (-v), lateral (ventral) setae of coxae II; pes-iii-lat (-v), lateral (ventral) setae of coxae III; pes-iv-a (-P), anterior (posterior) setae of coxae IV; P-1 to P-4, first to fourth segment of palp; L/W, the ratio of length to width; Hal-55/etc., specimen codes of the author's personal system. In the present paper the codes are given only to the described specimens.

In addition, the following abbreviations are used in the figure legends: Ds, dorsal view; Vr, ventral view; Lat, lateral view; R, right appendage (or part); L, left appendage (or part).

Family *Halacaridae* Murray, 1987  
(Japanese name: Ushiodani-ka)

Subfamily *Actacarinae* Viets, 1939  
(Japanese name: Nagisadani-aka, new)

Genus *Actacarus* Schulz, 1937  
(Japanese name: Nagisadani-zoku, new)

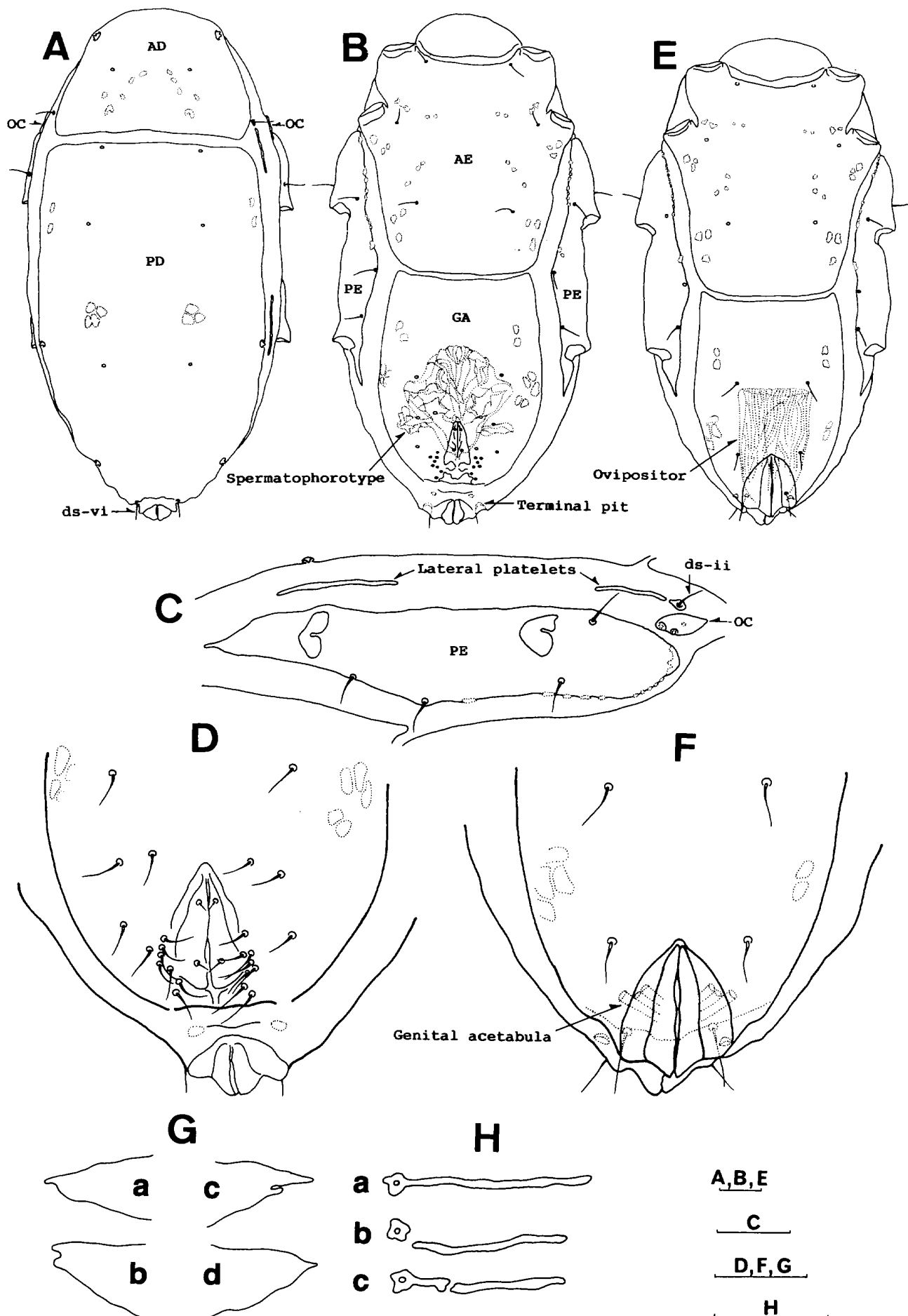
*Actacarus illustrans* Newell, 1951  
(Japanese name: Kita-nagisadani, new)  
(Figs. 2-6)

*Actacarus illustrans* Newell, 1951 [4], pp. 33-36, Figs. 126-140. (Holotype: Male, in American Museum of Natural History; type locality, Unalaska Island, Alaska.)

*Actacarus illustrans*: Krantz, 1976 [10], pp. 255-257, Tab. 5, Figs. 30-32. (Descriptions of immature stages with leg chaetotaxy in adult, record from Oregon.) (nec *A. illustrans* sensu Vorob'yeva and Yaroshenko, 1979 [11].)

**Specimens examined.** 3 males, 3 females: Inter-tidal, in coarse sand along shore line at low tide, Uchikabuto, Oshoro Bay (43°12'N, 140°51'E), Hokkaido, Sea of Japan, Japan, 26-VI-1986, H. Abé coll. — 1 deutonymph, 1 protonymph, 1 larva:

FIG. 2. *Actacarus illustrans*. Male (Hal-55): A, idiosoma (Ds); B, idiosoma (Vr); C, idiosoma (Lat, R); D, genitoanal region. Female (Hal-1): E, idiosoma (Vr); F, genitoanal region. Males & Females: G, posterior margin of PE (a, b: R; c, d: L); H, anterior lateral platelet (a-c: L). Scale bars=20  $\mu$ m.



Intertidal, in coarse sand and gravel along shore line at low tide, Shamodomari, Oshoro Bay, Hokkaido, Sea of Japan, Japan, 19-V-1987, H. Abé coll.—1 male, 1 deutonymph, 2 protonymphs: Intertidal, in coarse sand among boulders along shore line at high tide, Ebisu Rock, Oshoro Bay, Hokkaido, Sea of Japan, Japan, 23-VI-1987, H. Abé coll. The following American specimens were also examined for the purpose of comparison: 1 male, 1 female, 1 deutonymph, 1 protonymph: In coarse sand near bank, mouth of Schooner Creek, Pacific coast of Oregon, U.S.A., 18-VI-1974, G. W. and V. J. Krantz coll.

**Description.** *Male* (Hal-55): Idiosoma 256  $\mu\text{m}$  long, 128  $\mu\text{m}$  wide, color in life semitransparent with dark brown specks and a longitudinal white dorsal line medially.

**Dorsum** (Fig. 2A) almost completely covered with two dorsal plates, which are strongly ribbed, uniformly punctate and with small scattered alveoli. AD approximately 1/3 length of PD, L/W 0.66, furnished with a large pore on anterolateral corner on each side, a few minute canaliculi on anterolateral site, and paired weak areolae on surface of posterior half. PD 182  $\mu\text{m}$  long, 114  $\mu\text{m}$  wide, furnished with weak areolae anterolaterally, a cluster of three weak panels medially, and scattered minute canaliculi laterally on each side; two pores near lateral margin. OC (Fig. 2C) 16  $\mu\text{m}$  long, 8  $\mu\text{m}$  wide, lateromarginally placed. Two

lateral platelets (Fig. 2C) lying marginally on each side of idiosoma alongside AD and PD, quite narrow and very weakly sclerotized; the first platelet divided into anterior microplatelet, 3  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide, located dorsally to OC, and posterior microplatelet, 30  $\mu\text{m}$  long, 2  $\mu\text{m}$  wide, extending posteriorly to level about midway between anterior margin of PD and insertion of leg III; the second platelet lying parallel to PD, near insertion of leg IV.

**Chaetotaxy of dorsal region:** Setae ds-i on AD; ds-ii on anterior microplatelets, seen as if located on membranous cuticle from dorsal view; ds-iii, -iv, -v, -vi (adanal setae) on PD.

**Venter** (Fig. 2B) covered with four plates which are weakly ornamented in a manner similar to dorsal plates. AE 110  $\mu\text{m}$  long, 106  $\mu\text{m}$  wide, ornamented with tiny triangular epimeral processes, anteriorly with a thin membranous collar, with five sets of lateral and medial subsurface pores of various shapes. PE (Fig. 2C) 136  $\mu\text{m}$  long, 28  $\mu\text{m}$  wide, elongate, marked with some series of marginal subsurface pores ventrally.

**Chaetotaxy of epimeral region:** Setae aes-i, aes-ii-lat, aes-ii-v on AE; pes-iii-lat, pes-iii-v, pes-iv-a, pes-iv-p each on PE.

**Genitoanal region** (Fig. 2B, D): GA 180  $\mu\text{m}$  long, 108  $\mu\text{m}$  wide, reaching anteriorly just posterior to level of pes-iv-a, ornamented with two anterolateral subsurface pores and cluster of post-

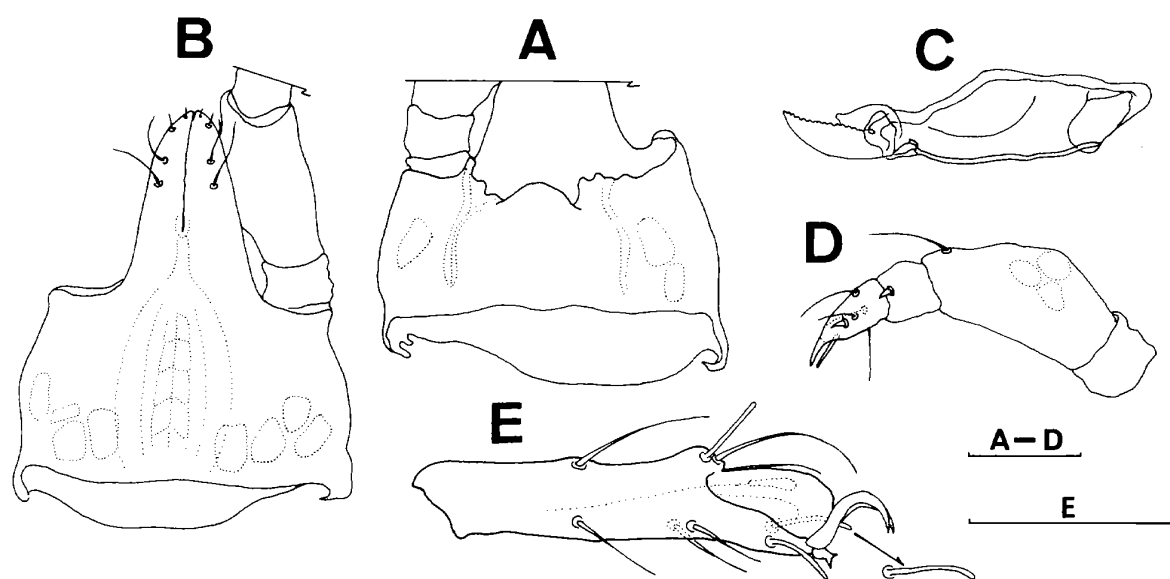


FIG. 3. *Actacarus illustrans*. Male (Hal-55): A, gnathosoma (Ds); B, gnathosoma (Vr); C, chelicera (L); D, palp (R); E, tarsus I (L). Scale bars = 20  $\mu\text{m}$ .

erolateral weak panels on each side. Genital foramen about  $1/4$  length of GA, L/W 1.95, triangular; anterior margin at 0.68 relative to GA length. Anal papilla terminal, well separated from genital foramen. A terminal pit (Fig. 2B) located laterally just adjacent to anal papilla on each side. Spermatophorotype (Fig. 2B) massive, approximately  $1/2$  length of GA, L/W 1.06.

**Chaetotaxy of genitoanal region:** One pair of outlying setae at 0.44 on GA; a group of eleven perigenital setae on each lateral side of genital foramen as illustrated in Fig. 2D; two subgenital setae on each genital sclerite, arranged 1-1. No setae on anal papilla.

**Gnathosoma** (Fig. 3A, B)  $70\ \mu\text{m}$  long,  $56\ \mu\text{m}$  wide, gnathosomal length/idiosomal length 1.06. Anterior margin of tectum weakly convex. Rostrum  $36\ \mu\text{m}$  long,  $26\ \mu\text{m}$  wide, furnished with four pairs of delicate rostral setae. Chelicera (Fig. 3C) with basal segment  $42\ \mu\text{m}$  long,  $16\ \mu\text{m}$  wide, partly punctate, with oblique proximal end. Movable digit approximately  $1/2$  length of basal segment, slightly inclined dorsally, bearing 16-18 minute denticles along dorsal edge. Fixed digit nearly  $1/2$  length of movable digit. Palp (Fig. 3D)  $61\ \mu\text{m}$

long, slightly inclined ventrally, with four free segments.

**Legs:** Length of legs I, II, III, IV = 194, 162, 174,  $192\ \mu\text{m}$ , respectively. Leg chaetotaxy as follows: Trochanters I-IV, 0-0-1-1; basifemora, 2-2-2-2; telofemora, 2-2-2-2; genua, 5-4-3-3; tibiae, 7-5-5-5. Tarsus I (Fig. 3E) with strongly developed posterior lamella, with three dorsal setae (one at intermediate level on basidorsal limb, others on claw fossa), one solenidion, one famulus, three filiform ventral setae (one intermediately, others distally), and two parambulacral setae (single euphathidai); solenidion fine, setiform, at base of fossary lamella; famulus minute, blade-like in form, with fine canaliculus, lying distally to solenidion; lateral claws small compared with those on other legs, with indistinct combs; median claw bidentate.

**Female (Hal-1):** Idiosoma  $242\ \mu\text{m}$  long,  $124\ \mu\text{m}$  wide, resembling male in essential details except for the sculpture of PD and characters of genitoanal region. PD furnished with only one weak panel at about mid-level on each side. **Genitoanal region** (Fig. 2E, F): Genital foramen  $32\ \mu\text{m}$  long,  $24\ \mu\text{m}$  wide, located terminally and covering anal fora-

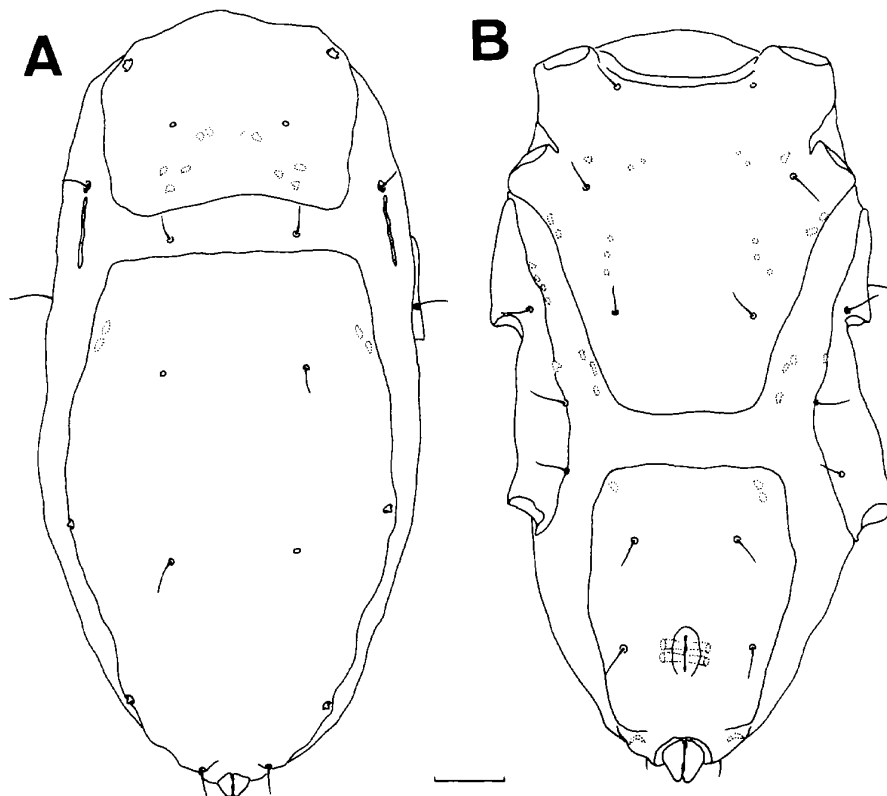


FIG. 4. *Actacarus illustrans*. Deutonymph (Hal-59): A, idiosoma (Ds); B, idiosoma (Vr). Scale bar =  $20\ \mu\text{m}$ .

men, furnished with three pairs of perigenital setae; the first pair at 0.40, the second at 0.62 (level of anterior margin of genital foramen), and the third at 0.87 (behind genital foramen occupying terminal concavity). Subgenital setae absent. Three pairs of genital acetabula (Fig. 2F) lying inside of genital foramen. Ovipositor (Fig. 2E) short, funnel-like, medially placed.

**Immature stages.** *Deutonymph* (Hal-59): Idiosoma 228  $\mu\text{m}$  long, 108  $\mu\text{m}$  wide. **Dorsum** (Fig. 4A): AD slightly concave posteriorly. PD extending anteriorly to level about midway between insertions of legs II and III. Setae ds-iii inserted in striated membranous cuticle between AD and PD. **Venter** (Fig. 4B): AE narrowed posteriorly from level of insertion of leg II to level of pes-iv-a. Lateral platelets short and weakly sclerotized. A number of subsurface pores present on membranous cuticle between AE and PE. GA 78  $\mu\text{m}$  long, 60  $\mu\text{m}$  wide, extending anteriorly to level of pes-iv-p, furnished with two pairs of perigenital setae and internal genital acetabula. **Legs:** Basifemur IV has only one seta.

*Protonymph* (Hal-58): Idiosoma 236  $\mu\text{m}$  long,

108  $\mu\text{m}$  wide. **Dorsum** (Fig. 5A): AD not reaching posteriorly to level of ds-ii. PD extending anteriorly to level of insertion of leg III. **Venter** (Fig. 5B): AE strongly narrowed posteriorly from level of insertion of leg II, with truncated posterior end at level about midway between pes-iii-v and pes-iv-p. Setae pes-iv-a lacking. Several subsurface pores located on membranous cuticle between AE and PE. GA 54  $\mu\text{m}$  long, 46  $\mu\text{m}$  wide, not reaching anteriorly to level of trochanter IV, without setae, bearing one pair of genital acetabula. **Legs:** Basifemur III with only one seta; trochanter IV without setae; femur IV undivided.

*Larva* (Hal-61): Idiosoma 168  $\mu\text{m}$  long, 92  $\mu\text{m}$  wide. **Dorsum** (Fig. 6A): AD and PD separated from each other by about the same length of AD. Lateral pores on AD and PD relatively large, distinct. Two subsurface pores placed on membranous cuticle dorsoposterior to OC. **Venter** (Fig. 6B): AE lacking aes-ii-lat. PE (Fig. 6C) small, with only one seta ventrally. Two very weakly sclerotized lateral microplatelets lying posterior to each of ds-ii. GA 28  $\mu\text{m}$  long, 32  $\mu\text{m}$  wide, square in outline, lacking both genital setae and genital

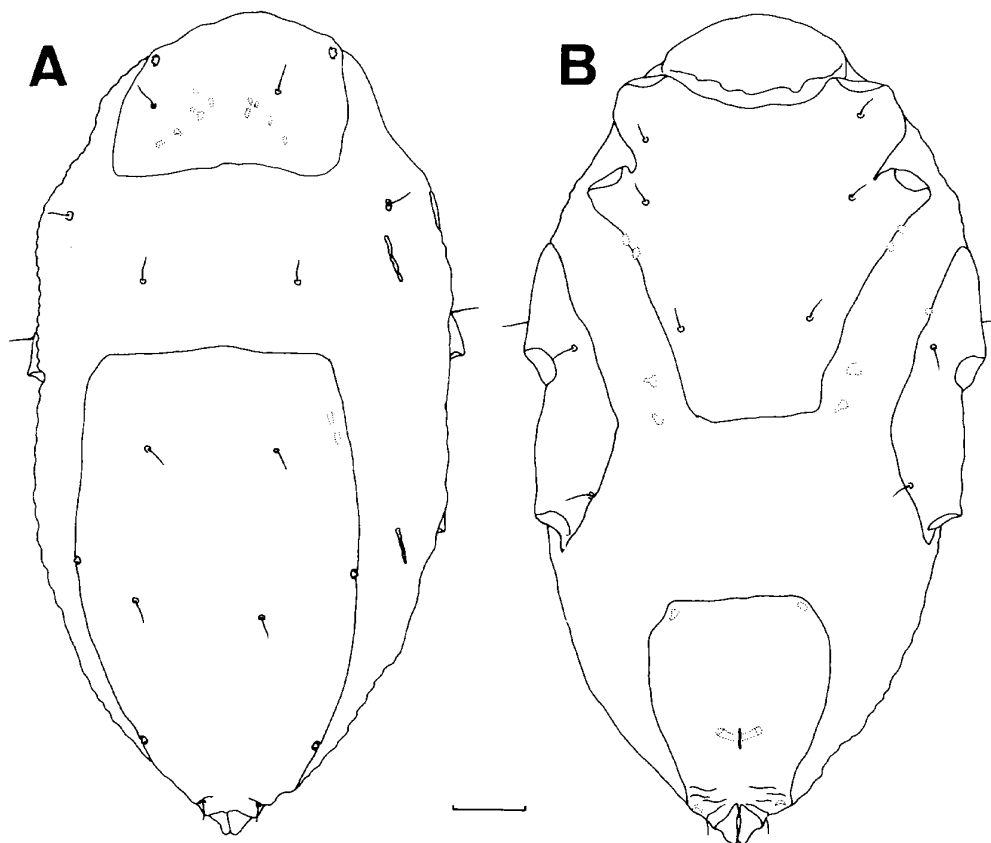


FIG. 5. *Actacarus illustrans*. Protonymph (Hal-58): A, idiosoma (Ds); B, idiosoma (Vr). Scale bar = 20  $\mu\text{m}$ .

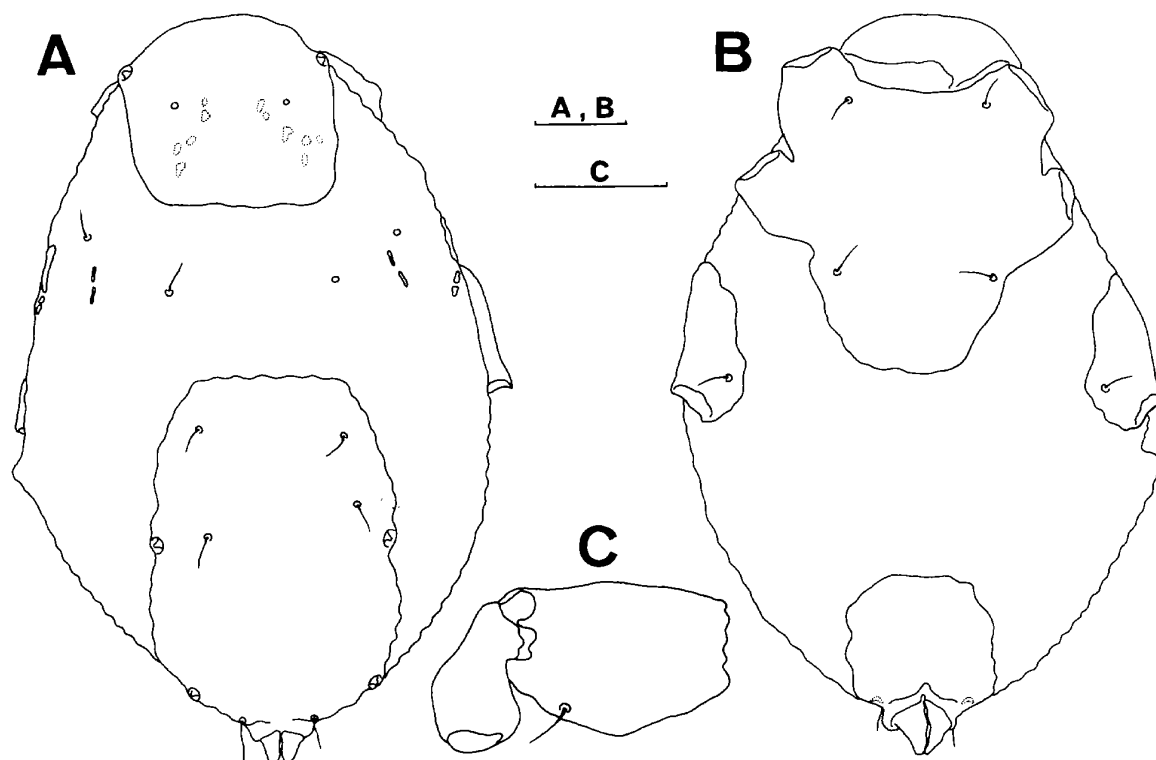


FIG. 6. *Actacarus illustrans*. Larva (Hal-61): A, idiosoma (Ds); B, idiosoma (Vr); C, PE with trochanter of leg III (R). Scale bars = 20  $\mu$ m.

slit. *Legs* three pairs; basifemur and telofemur fused. Leg chaetotaxy as follows: Trochanters I-III, 0-0-1; femora, 3-3-3; genua, 4-4-3; tibiae, 5-5-5.

**Morphological variation and abnormality:** The number of panels comprising a cluster at about mid-level on each side of PD was from two to four in the male, and one to two in the female. The outline of the posterior margin of PE (Fig. 2G; a-d) differed among specimens and even between sides of one specimen. The microplatelets forming the first lateral platelet on each side of the idiosoma usually were separate, but in some cases were fused (Fig. 2H; a-c). Several specimens had three subsurface pores on one side of GA. A few male specimens had only ten perigenital setae on one side of the genital foramen. Basifemur IV had two setae in the described male specimen, but most of the adult specimens examined had only one seta. One deutonymph specimen retained the protonymphal condition in leg segmentation, with leg IV being five-segmented instead of six.

**Distribution:** Hitherto recorded from the north-eastern Pacific coasts of Alaska and Oregon in U.S.A. This is the first record of *A. illustrans* from

the western part of the northern Pacific.

*Actacarus illustrans* sensu Vorob'yeva and Yaroshenko [11] from the northwestern part of the Black Sea is identical with *A. bacescui* Konnerth-Ionescu, 1970 (= *A. illustrans* sensu Monniot, 1968 = *A. monniotae* Krantz, 1974) which was originally described from the Black Sea as a subspecies of *A. illustrans* and has been confused with *A. illustrans* Newell, 1951.

**Remarks:** *Actacarus illustrans* Newell, 1951 was originally described from the intertidal zone at Dutch Harbor, Unalaska Island [4], and its immature stages were described by Krantz [10]. The adult specimens from Hokkaido, northern Japan, accord well with the original description in the following characters: Setae ds-ii on membranous cuticle (on microplatelets forming the first lateral platelets); three pairs of setae on AE; four setae on PE (one dorsally, three ventrally); GA furnished with one pair of outlying setae and eleven perigenital setae in the male; ovipositor funnel-shaped and occupying nearly one third of the distance between each anterior margin of genital foramen and GA.

On the other hand, Japanese adult specimens

deviate from the original description in the following points (corresponding conditions in the original description in parentheses if necessary): (1) Somewhat larger body size: Male 252–260  $\mu\text{m}$ ,  $n=4$  (240–246  $\mu\text{m}$ ,  $n=3$ ); female 242–248  $\mu\text{m}$ ,  $n=3$  (227–240  $\mu\text{m}$ ,  $n=3$ ); (2) idiosoma with weakly sclerotized lateral platelets (no reference to the platelets); (3) anterior margin of tectum weakly convex (bilobed, from illustration); (4) leg chaetotaxy; (5) median claw on tarsus I bidentate (unidentate); (6) tarsus I with ten setae including solenidion and famulus (seven setae; solenidion and famulus lacking); (7) arrangement of perigenital setae in the male: Anterior two pairs of perigenital setae located anteriorly (posteriorly) to level of anterior margin of genital foramen, and one of the remaining nine pairs lying laterally and distant from lateral sides of genital foramen (all nine pairs located in the vicinity of genital foramen); and (8) three pairs of distinct perigenital setae in the female (two pairs).

Of these discrepancies between the specimens under study and the original description, the difference in body size (1) is probably attributable to the individual variation or sampling errors due to the small sample size. Other inconsistencies may reflect the insufficient original description, as shown below: (i) As for the leg chaetotaxy (4), the present material accords well with the description later provided by Krantz [10] on the basis of specimens from Schooner Creek, Oregon; (ii) as regards the anterior margin of the tectum (3) and bidentate median claw on tarsus I (5), the present specimens correspond well with the later description by Krantz [12] based on the *paratype series*; (iii) as for the setae on tarsus I (6) and female perigenital setae (8), Newell [7] later treated these features as found in the Japanese material as the generic characters of the genus *Actacarus*, although he did not specifically emend his original description of these characters in *A. illustrans*; (iv) the lateral platelets of the idiosoma (2) are very slender and lateromarginal in position so that they are not clearly visible in dorsal and ventral views;

these platelets are actually present both in immatures [10] and adults [Abé, the present study] of *A. illustrans* from Schooner Creek. Newell [13] might have overlooked them; (v) the comparison between specimens from Hokkaido and those from Schooner Creek shows the close resemblance in the arrangement of perigenital setae (7) between specimens from these two localities, so that it is probable that Newell [13] figured perigenital setae somewhat insufficiently in his original description.

Krantz [10] described for the first time immature stages of *A. illustrans* on the basis of specimens from Schooner Creek. According to him, deutonymphs have very poorly developed dorsal plates, and this author verified his observation in the deutonymph specimen from Schooner Creek. The Japanese deutonymph specimens have well developed dorsal plates.

*Actacarus karoensis* sp. nov.

(Japanese name: Karo-nagisadani, new)

(Figs. 7–11)

*Type series. Holotype*: Male, intertidal, in fine sand along shore line, Karo Beach (35°33'N, 134°13'E), Tottori Pref., Sea of Japan, Japan, 6-X-1987, N. Tsurusaki coll.—*Allotype*: Female, data same as the *holotype*.—*Paratypes*: 1 male, 3 protonymphs, 1 larva, data same as the *holotype*; 5 males, 3 females, 1 deutonymph, same locality as the *holotype*, 10-VI-1987, N. Tsurusaki coll.

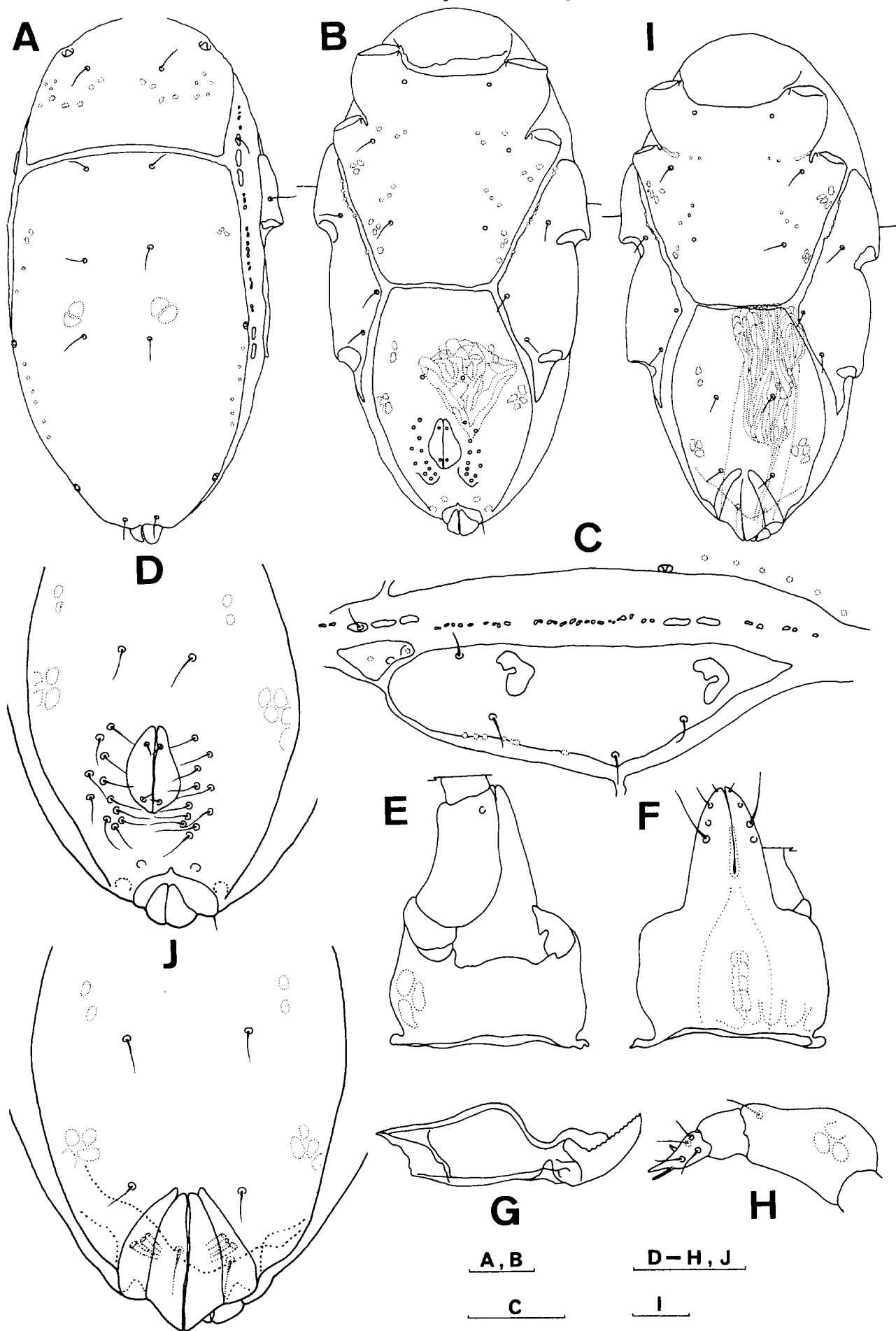
*Type deposition*: The type series is deposited in the collections of the National Science Museum, Tokyo, the Zoological Institute, Faculty of Science, Hokkaido University, Sapporo, the National Museum of Natural History, Smithsonian Institution, Washington, DC, U.S.A., and in my private collection.

*Description. Male* (holotype): Idiosoma small, compact, 174  $\mu\text{m}$  long, 82  $\mu\text{m}$  wide, color semi-transparent after a few weeks preservation in fixative. Color in life unknown.

*Dorsum* (Fig. 7A) almost completely covered with two dorsal plates which are uniformly punc-

FIG. 7. *Actacarus karoensis* sp. nov. Male (holotype): A, idiosoma (Ds); B, idiosoma (Vr); C, idiosoma (Lat, L); D, genitoanal region; E, gnathosoma (Ds); F, gnathosoma (Vr); G, chelicera (R); H, palp (R). Female (allotype): I, idiosoma (Vr); J, genitoanal region. Scale bars = 20  $\mu\text{m}$ .





tate with fine sparse alveoli. Dorsal setae very fine. AD and PD separated from each other by a narrow strip of finely striated membranous cuticle, opposing portion of AD and PD rectangular. AD approximately 1/3 length of PD, L/W 0.66, moderately convex anteriorly, very slightly concave posteriorly, furnished with a large pore on anterolateral corner on each side, ornamented with paired weak areolae and a number of laterally scattered minute canaliculi at about mid-level. PD 124  $\mu\text{m}$  long, 76  $\mu\text{m}$  wide, very weakly convex anteriorly, narrow, concave and faintly ribbed posteriorly, ornamented with tiny anterolateral areolae; a pair of weak intermediate panels and a series of lateral minute canaliculi on each side; two pores on each lateral margin; the first pore at 0.50 and the second at 0.88. OC (Fig. 7C) 15  $\mu\text{m}$  long, 8  $\mu\text{m}$  wide, lateromarginally placed, lying at dorsal side of anterior angle of PE, nearly triangular in outline with pointed anterior end, furnished with a small pore medially, a larger pore near posteroventral margin, and an oval apodeme at posterior end. A series of many microplatelets (Fig. 7C) lying marginally on each side of idiosoma alongside AD and PD, of which three anterior and two posterior microplatelets are relatively large and elliptical; anterior three larger microplatelets lying at level between OC and insertion of leg III, all approximately equal in size (4  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide); two larger posterior microplatelets lying at level of insertion of leg IV, each approximately 6  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide.

*Chaetotaxy of dorsal region:* Setae ds-i on PD at 0.43; ds-ii on the anteriormost larger microplatelets, seen as if placed on membranous cuticle from dorsal view; ds-iii on PD, each separated posteriorly from anterior margin of PD by approximately four alveolar diameters; ds-iv on PD at 0.43; ds-v on PD, at 0.50; ds-vi (adanal setae) on PD, each separated from posterior margin of PD by about five alveolar diameters.

*Venter* (Fig. 7B) covered with four plates weakly ornamented in a manner similar to dorsal plates. AE 68  $\mu\text{m}$  long, 64  $\mu\text{m}$  wide, subrectangular in outline, reaching posteriorly to level about midway between insertions of legs III and IV, very slightly concave posteriorly, furnished with tiny triangular epimeral processes, with a thin membranous collar

anteriorly, and five sets of lateral and medial subsurface pores of various shapes. PE (Fig. 7C) 82  $\mu\text{m}$  long, 24  $\mu\text{m}$  wide, elongate, tapering posteriorly from 0.57, moderately convex anteriorly, and strongly outcurved ventrally, with bluntly pointing terminal end, marked with a series of marginal subsurface pores ventrally.

*Chaetotaxy of epimeral region:* Setae aes-i on AE, each separated posteriorly from anterior margin of AE by about six alveolar diameters; aes-ii-lat on AE, posterior and somewhat medial to insertion of leg III; aes-ii-v on AE, at level of insertion of leg III; pes-iii-lat each on PE, on dorsolateral margin of PE at level about midway between anterior margin of PE and insertion of leg III; pes-iii-v each on PE, at level slightly anterior to insertion of leg III, separated from ventral margin of PE by approximately six alveolar diameters; pes-iv-a each on PE, at ventral apex of PE, separated from margin by about three alveolar diameters; aes-iv-p each on PE, at level anterior to insertion of leg IV, separated from ventral margin of PE by about three alveolar diameters.

*Genitoanal region* (Fig. 7B, D): GA 72  $\mu\text{m}$  long, 54  $\mu\text{m}$  wide, almost truncated anteriorly, extending slightly anterior to level of pes-iv-a, almost touching posterior margin of AE, moderately expanded intermediately and narrowed posteriorly to terminal end; two subsurface pores found anterolaterally and a cluster of lateral weak panels at about mid-level on each side. Genital foramen about 1/4 length of GA, L/W 1.50, pyriform in outline; anterior margin of foramen at 0.60 relative to GA length. Anal papilla terminally placed, well separated from genital foramen. A terminal pit (Fig. 7B) located laterally on each side of anal papilla. Spermatophorotype (Fig. 7B) L/W 1.17, massive, complex in structure, approximately 1/2 length of GA.

*Chaetotaxy of genitoanal region:* One pair of outlying setae located at 0.42 on GA; a group of eleven perigenital setae on each side of genital foramen as illustrated in Fig. 7D; two subgenital setae on each genital sclerite, arranged 1-1. No setae on anal papilla.

*Gnathosoma* (Fig. 7E, F): 52  $\mu\text{m}$  long, 36  $\mu\text{m}$  wide, gnathosomal length/idiosomal length 0.30; base of gnathosoma L/W 0.78, slightly expanded

laterally, lacking setae, entirely ornamented with fine punctations, and with a few round panels on dorsolateral and ventroproximal sites. Pharyngeal plate fusiform, with eight visible panels. Anterior margin of tectum weakly convex. Rostrum  $24\ \mu\text{m}$  long,  $18\ \mu\text{m}$  wide, subtriangular with round tip, just reaching to level of distal end of P-2, bearing four pairs of delicate filiform setae as follows: Protorostral setae minute, near tip; deuterostral setae short, posterior to protorostral setae; tritrostral and basirostral setae long, approximately four times as long as deuterostral setae, located at 0.14 and 0.21 relative to rostral length, respectively. Rostral sulcus reaching to about  $2/3$  level relative to rostral length. Chelicera (Fig. 7G) with

basal segment  $30\ \mu\text{m}$  long,  $14\ \mu\text{m}$  wide, strongly convex anterodorsally, with oblique proximal end and indistinct ornamentation. Movable digit approximately  $2/3$  length of basal cheliceral segment, strongly inclined dorsally, with 16-18 minute denticles along dorsal edge. Fixed digit nearly  $1/2$  length of movable digit. Palp (Fig. 7H)  $48\ \mu\text{m}$  long, inserted dorsolaterally, slightly inclined ventrally, with four free segments as described below: P-1 short, cylindrical, L/W 1.25; P-2 longest and robust, exceeding combined length of P-3 and P-4, L/W 1.43, slightly expanded dorsoproximally, ornamented with fine faint punctations and a few faint panels, with one distidorsal filiform seta; P-3 about the same length as P-1, L/W 0.75, with one

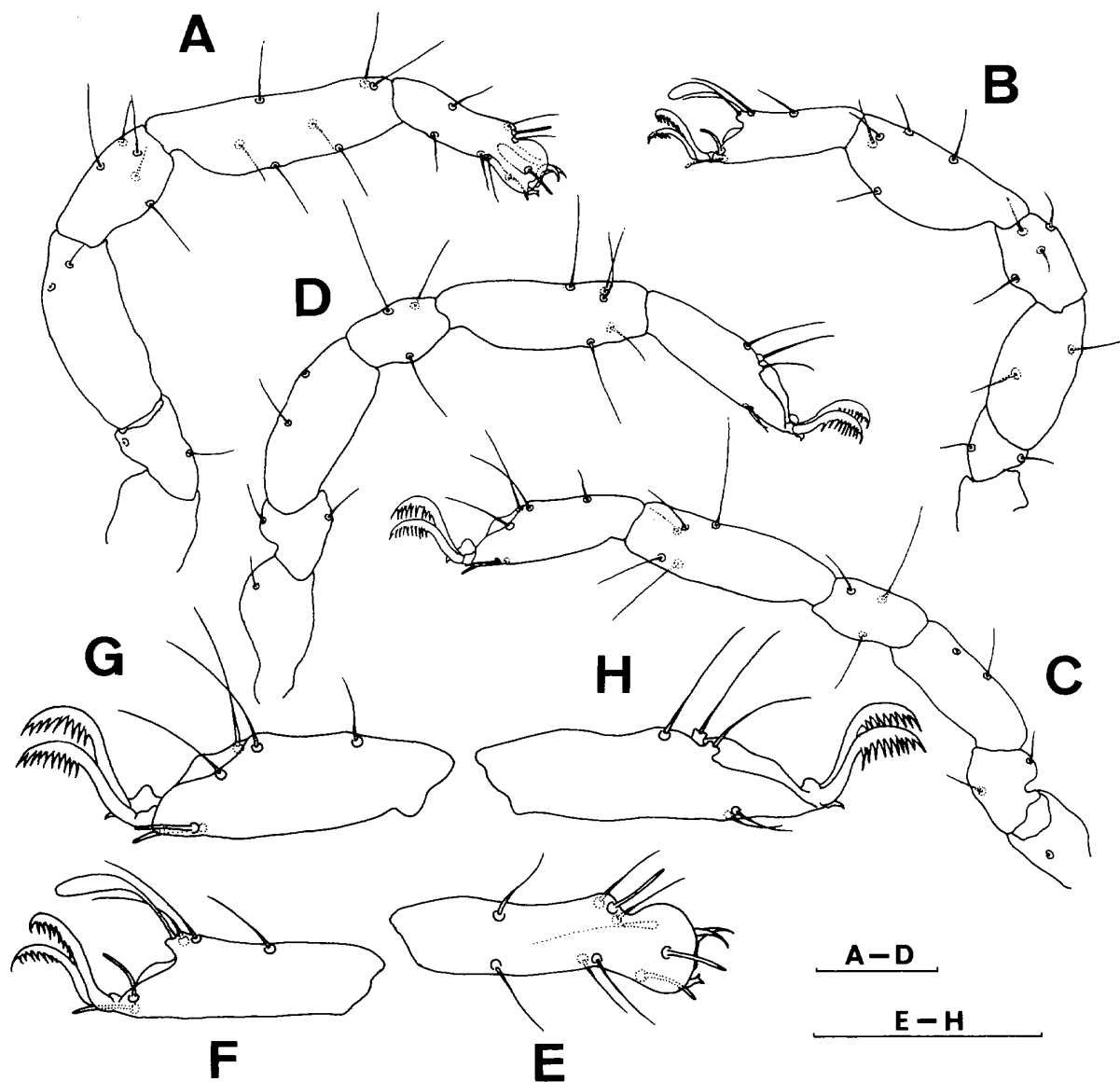


FIG. 8. *Actacarus karoensis* sp. nov. Male (holotype): A, leg I (R); B, leg II (R); C, leg III (L); D, leg IV (L); E, tarsus I (R); F, tarsus II (R); G, tarsus III (L); H, tarsus IV (L). Scale bars =  $20\ \mu\text{m}$ .

short spiniform seta anterodistally; P-4 conical, slightly curved ventrally, furnished with three slender filiform setae proximally, one slender filiform seta and one short spiniform seta intermediately, and one distal bacilliform seta parallel to terminal blunt spiniform seta.

**Legs** (Fig. 8A-D): Length of legs I, II, III, IV = 138, 112, 128, 130  $\mu\text{m}$ , respectively, thin, with fine faint punctations on all segments. Each tarsus with claw fossa. Lateral claws with indistinct accessory processes. Median claw of each leg minute, bidentate only in leg I, unidentate in others. Carpite and cavity in claw not clear. Parambulacral setae all single euphathidia.

**Leg chaetotaxy** as follow: Trochanters I-IV, 0-0-1-1; basifemora, 2-2-2-2; telofemora, 2-2-2-2; genua, 5-4-3-3; tibiae, 7-5-5-5. Tarsus I (Fig. 8E) with strongly developed posterior lamella, with three dorsal setae (one intermediate seta on basidorsal limb, others on claw fossa), one solenidion, one famulus, three filiform ventral setae (one intermediately, others distally), and two parambulacral setae; solenidion fine setiform, at the base of fossary lamella; famulus minute, blade-shaped, with fine canaliculus, lying distally to solenidion; lateral claws small compared with those on other legs, and combs not in visible. Tarsus II (Fig. 8F) with three dorsal setae (one filiform intermediate seta on basidorsal limb, two filiform setae on claw fossa), one distally swollen solenidion at the base of fossary lamella, two parambulacral setae; lateral claws with weakly developed combs. Tarsus III (Fig. 8G) with four dorsal setae (one filiform intermediate seta, one filiform distal seta on basidorsal limb, and two filiform setae on claw fossa), two parambulacral setae; lateral claws with well developed combs. Tarsus IV (Fig. 8H) with three dorsal setae (one filiform distal seta on basidorsal limb, two filiform setae on claw fossa), two parambulacral setae; lateral claws as in tarsus III.

**Female** (allotype): Idiosoma 190  $\mu\text{m}$  long, 94  $\mu\text{m}$  wide, resembling male in essential details except for the characters of weak panels on PD and genitoanal region. **Dorsum**: PD furnished with only one weak panel near lateral margin on each side.

**Genitoanal region** (Fig. 7I, J): Genital foramen 26  $\mu\text{m}$  long, 14  $\mu\text{m}$  wide, located terminally and

overlying anal foramen, furnished with three pairs of perigenital setae; the first pair at 0.39, the second at 0.69 (level of anterior margin of foramen), and the third at 0.84 (behind the foramen occupying terminal concavity). Subgenital setae lacking. Genital acetabula (Fig. 7J) internal, three pairs. Ovipositor (Fig. 7I) long, tubular, extending to level near insertion of leg IV, slightly shifted to one side from idiosomal longitudinal median axis, although not reaching to lateral side of idiosoma.

**Immature stages**: Three immature stages of *A. karoensis* are distinguished. They differ from adults in that 1) plates are less developed and more widely separated from each other by distinctly striated membranous cuticle, 2) smaller lateral microplatelets are almost indistinct, 3) AD and PD more ribbed and furnished with more canaliculi, 4) PD lacks a cluster of weak panels at mid-level on each side, and 5) legs are shorter and more weakly punctate.

**Deutonymph** (paratype, Hal-63): Idiosoma 180  $\mu\text{m}$  long, 84  $\mu\text{m}$  wide. **Dorsum** (Fig. 9A): Setae ds-iii placed on striated membranous cuticle between AD and PD. PD truncated anteriorly, extending to level of slightly posterior to ds-iii. **Venter** (Fig. 9B): AE strongly narrowed posteriorly from level of insertion of leg II to level of anterior to pes-iv-a. GA 62  $\mu\text{m}$  long, 52  $\mu\text{m}$  wide, reaching anteriorly to level about midway between pes-iv-a and pes-iv-p, furnished with two subsurface pores on each anterolateral corner, bearing two pairs of perigenital setae; the first pair at 0.27; the second at lateral sides of genital field. Primordial genital slit very weakly sclerotized, reaching anteriorly to 0.58 relative to GA length. Subgenital setae lacking. Genital acetabula internal, two pairs. **Legs** (Fig. 9C-F): Basifemur IV with only one seta.

**Protonymph** (paratype, Hal-90): Idiosoma 160  $\mu\text{m}$  long, 78  $\mu\text{m}$  wide. **Dorsum** (Fig. 10 A): Posterior margin of AD not reaching to mid-level between insertions of legs II and III. Only two lateral microplatelets located dorsoposterior to OC. **Venter** (Fig. 10 B): Posterior margin of AE extending to level about midway between pes-iii-lat and pes-iv-p. Setae pes-iv-a lacking. GA 46  $\mu\text{m}$  long, 34  $\mu\text{m}$  wide, reaching anteriorly to level

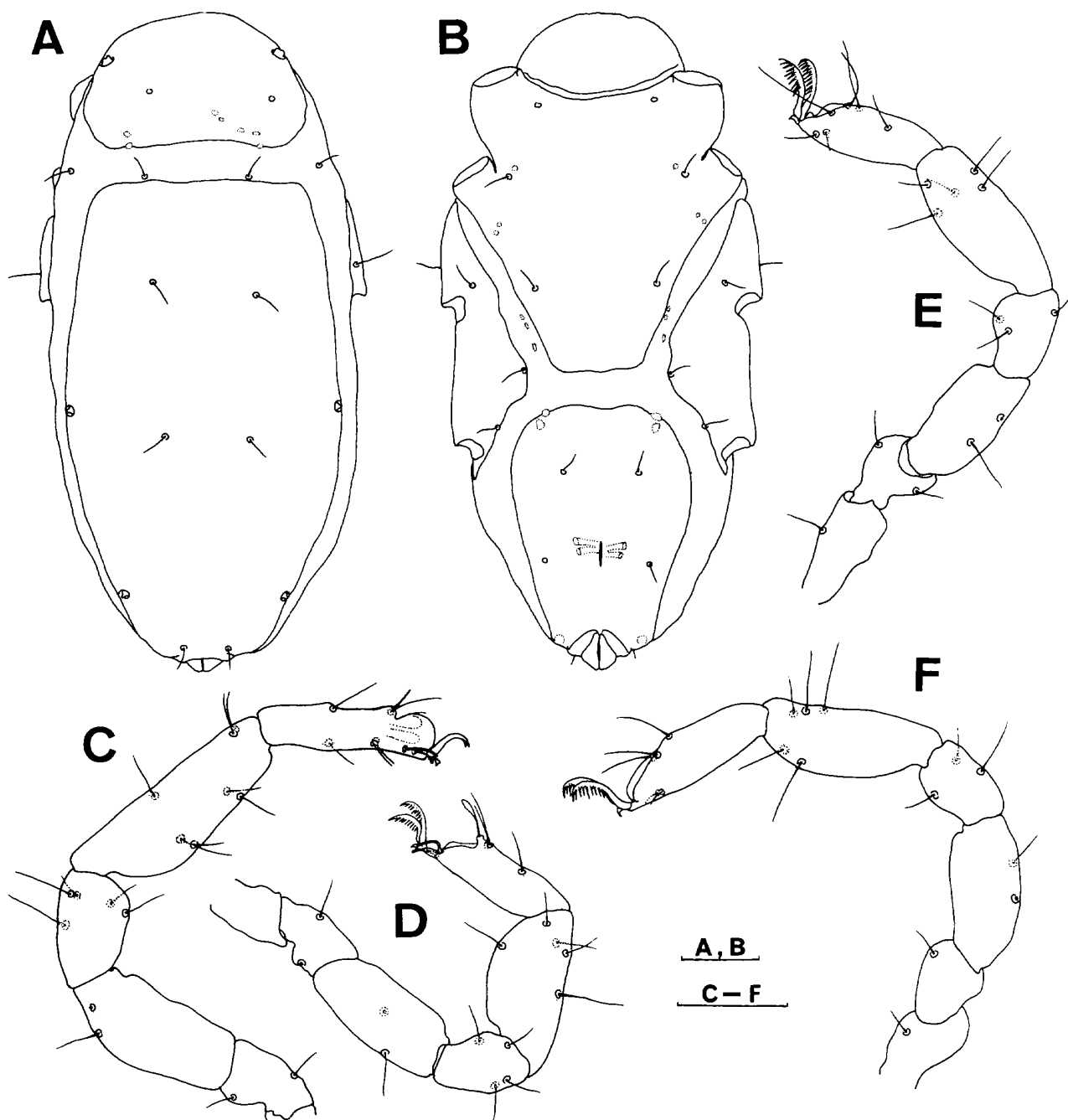


FIG. 9. *Actacarus karoensis* sp. nov. Deutonymph (paratype, Hal-63): A, idiosoma (Ds); B, idiosoma (Vr); C, leg I (R); D, leg II (R); E, leg III (R); F, leg IV (R). Scale bars=20  $\mu$ m.

slightly posterior to pes-iv-p, lacking setae, bearing one pair of internal genital acetabula that flank the primordial genital slit. Anterior margin of genital slit at 0.61 relative to GA length. *Legs* (Fig. 10C-F): Basifemur III with only one seta, trochanter IV without setae, femur IV undivided.

*Larva* (paratype, Hal-93): Idiosoma 140  $\mu$ m long, 72  $\mu$ m wide. *Dorsum* (Fig. 11A): AD and PD separated from each other by interval of approximately 2/3 length of PD. Lateral pores on

AD and PD relatively large and distinct. Lateral microplatelets very faint, lying dorsoposteriorly to OC. *Venter* (Fig. 11B): AE lacking aes-ii-lat. PE small, with only one seta and marginal subsurface pores ventrally. Two subsurface pores located on membranous cuticle between AE and PE. GA 22  $\mu$ m long, 22  $\mu$ m wide, trapezoidal, weakly protruding anteriorly, lacking both genital setae and genital slit. *Legs* (Fig. 11C-E) three pairs; basifemur and telofemur fused. Leg chaetotaxy as

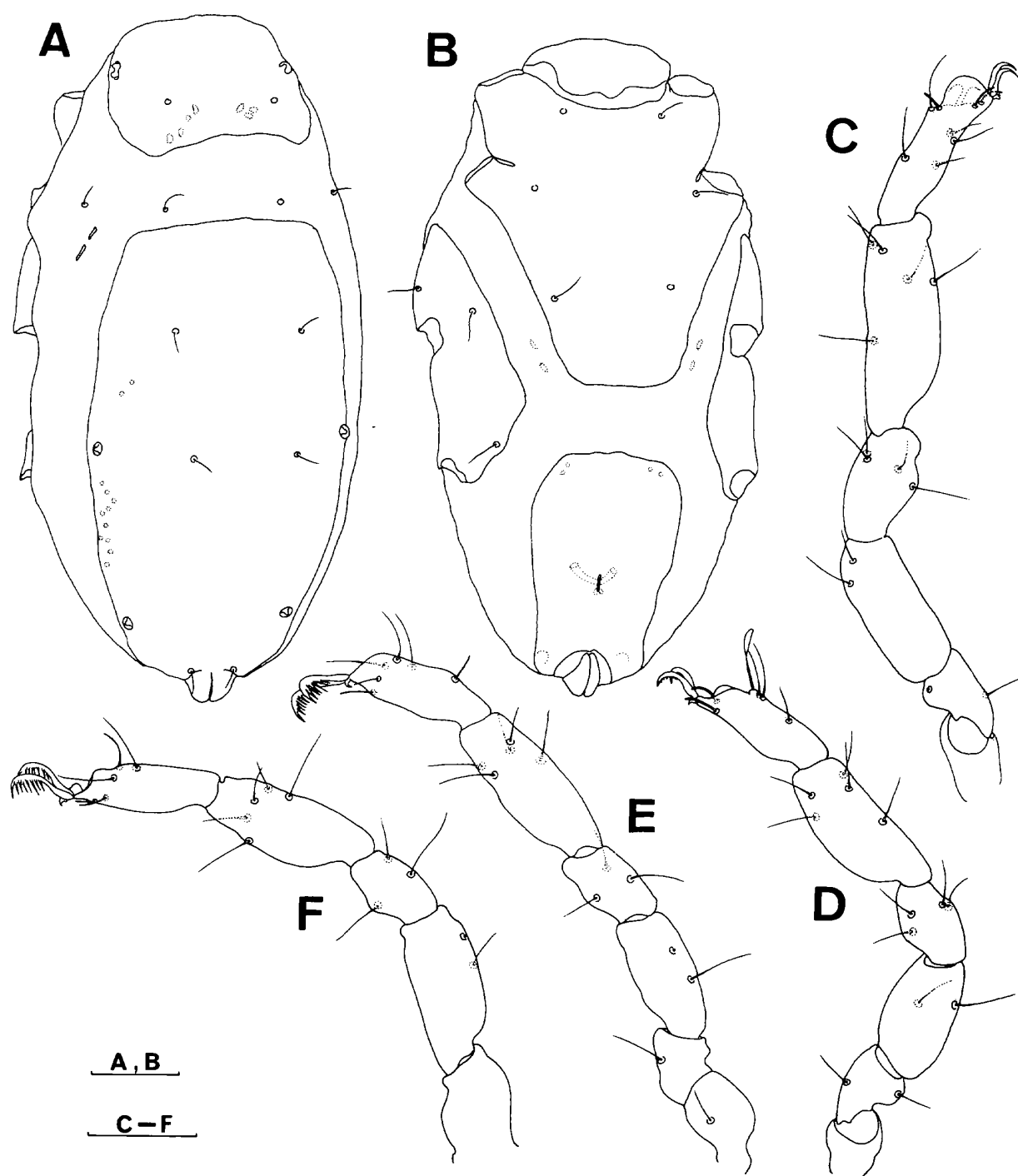


FIG. 10. *Actacarus karoensis* sp. nov. Protonymph (paratype, Hal-90): A, idiosoma (Ds); B, idiosoma (Vr); C, leg I (R); D, leg II (R); E, leg III (R); F, leg IV (R). Scale bars=20  $\mu$ m.

follows: Trochanters I-III, 0-0-1; femora, 3-3-3; genua, 4-4-3; tibiae, 5-5-5.

**Morphological variation and abnormality:** The number of panels comprising a cluster at the intermediate level on each side of PD was from two to three in the male. The shape and the arrangement of the lateral microplatelets were variable even between sides of one specimen,

although the larger microplatelets were more stable. Two male specimens of the *type series* had only ten perigenital setae on one side of the genital foramen.

**Distribution:** Tottori Prefecture, Sea of Japan, Japan.

**Remarks:** *Actacarus karoensis* is distinguished from congeners on the basis of the following

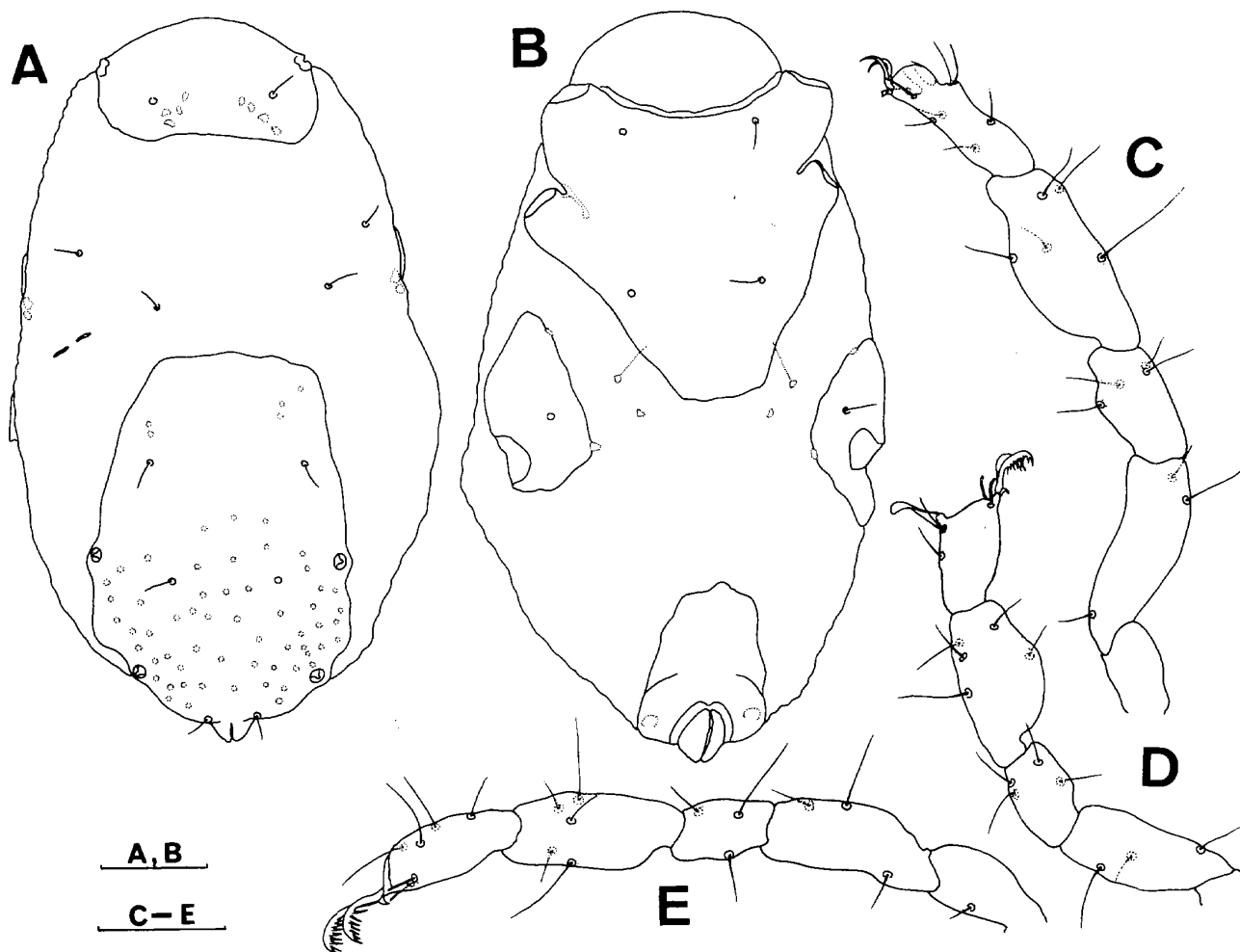


FIG. 11. *Actacarus karoensis* sp. nov. Larva (paratype, Hal-93): A, idiosoma (Ds); B, idiosoma (Vr); C, leg I (L); D, leg II (L); E, leg III (R). Scal bars = 20  $\mu$ m.

characters: Setae ds-ii on lateral microplatelets; three setae on PE (one dorsally, three ventrally); GA expanded medially, furnished with one pair of outlying setae and eleven pairs of perigenital setae as illustrated in Fig. 7D; anterior margin of tectum very weakly convex; ovipositor extending to level of insertion of leg IV; a series of weakly sclerotized lateral microplatelets laterad from AD and PD on each side of idiosoma.

Morselli and Mari [14] mentioned that *A. clipeolatus* may be distinguished from congeners by the presence of two lateral platelets laterad from AD and PD on each side of the idiosoma. In the present study, however, both the *Actacarus* species examined have the lateral platelets laterad from AD and PD. Therefore, the presence of these platelets cannot be regarded as a critical specific character. It is even possible that the

existence of the lateral platelets or the lateral microplatelets is one of the generic characters of the genus *Actacarus*, and the shape and the size of these platelets might be of specific significance.

The specific epithet is derived from the type locality, "Karo".

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